

(Unclassified Paper)

AD-A250 337

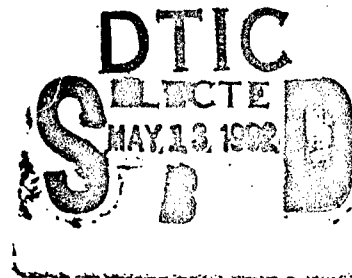


NAVAL WAR COLLEGE  
Newport, R.I.

ANTI-ENVIRONMENTAL WARFARE:  
PROTECTING THE ENVIRONMENT DURING WARTIME


by

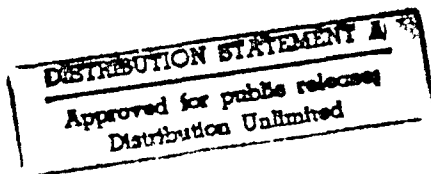
Richard O. Gamble II  
LCDR, CEC, USN



A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

Signature: 



19 June 1992

Paper directed by  
CAPT H.W. Clark, Jr. USN  
Chairman, Department of Operations

20030220/82

92-12691



02 5 11 163

## REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION <b>UNCLASSIFIED</b>			1b RESTRICTIVE MARKINGS	
2a SECURITY CLASSIFICATION AUTHORITY			3 DISTRIBUTION/AVAILABILITY OF REPORT DISTRIBUTION STATEMENT A: Approved for Public Release; distribution is unlimited.	
2b DECLASSIFICATION/DOWNGRADING SCHEDULE			5 MONITORING ORGANIZATION REPORT NUMBER(S)	
4 PERFORMING ORGANIZATION REPORT NUMBER(S)			7a NAME OF MONITORING ORGANIZATION	
6a NAME OF PERFORMING ORGANIZATION OPERATIONS DEPARTMENT		6b OFFICE SYMBOL (If applicable) C	7b ADDRESS (City, State, and ZIP Code)	
6c ADDRESS (City, State, and ZIP Code) NAVAL WAR COLLEGE NEWPORT, R.I. 02841			9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8a NAME OF FUNDING/SPONSORING ORGANIZATION		8b OFFICE SYMBOL (If applicable)	10 SOURCE OF FUNDING NUMBERS	
8c ADDRESS (City, State, and ZIP Code)			PROGRAM ELEMENT NO.	PROJECT NO.
			TASK NO.	WORK UNIT ACCESSION NO.
11 TITLE (Include Security Classification) Anti-Environmental Warfare: Protecting the Environment During Wartime (2)				
12 PERSONAL AUTHOR(S) Richard O. Gamble, II, LCDR, CEC, USN				
13a TYPE OF REPORT FINAL	13b TIME COVERED FROM TO	14 DATE OF REPORT (Year, Month, Day) 1991 February 13	15 PAGE COUNT 37	
16 SUPPLEMENTARY NOTATION A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Operations. The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.				
17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	Environmental Law, Environmental Policy, Rules of Engagement, Environmental Warfare, Nuclear Industry, Chemical Industry, Petroleum Industry, Dams, (over)	
19 ABSTRACT (Continue on reverse if necessary and identify by block number) This paper analyzes the operational impact resulting from the growing legal and political concerns over the environment during wartime. Current international law and national policies are examined to determine their potential effect on Rules of Engagement, and the resulting operational impact on means and methods of warfare. As illustrated during the recent Persian Gulf War, coalition leaders will be operationally constrained by political demands to protect the environment, and to mitigate ecological destruction caused by an opposing force. These constraints will effect how offensive action is conducted against environmentally sensitive industries including nuclear, chemical and petroleum. Commanders must adhere to the current environmental policies and place more emphasis on the principles of discrimination and military necessity in selecting and striking targets. Concurrently, commanders must balance protecting the environment and the requisite minimum casualties to obtain the objectives and preserve public support.				
20 DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS			21 ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
22a NAME OF RESPONSIBLE INDIVIDUAL CHAIRMAN, OPERATIONS DEPARTMENT			22b TELEPHONE (Include Area Code) 841-3414	22c OFFICE SYMBOL C

Block 18 (cont'd)

Weapons, Special Forces, Media, Intelligence,

Abstract of  
ANTI-ENVIRONMENTAL WARFARE:  
PROTECTING THE ENVIRONMENT DURING WARTIME

This paper analyzes the operational impact resulting from the growing legal and political concerns over the environment during wartime. Current international law and national policies are examined to determine their potential effect on Rules of Engagement, and the resulting operational impact on means and methods of warfare. As illustrated during the recent Persian Gulf War, coalition leaders will be operationally constrained by political demands to protect the environment, and to mitigate ecological destruction caused by an opposing force. These constraints will effect how offensive action is conducted against environmentally sensitive industries including nuclear, chemical and petroleum. Commanders must adhere to the current environmental policies and place more emphasis on the principles of discrimination and military necessity in selecting and striking targets. Concurrently, commanders must balance protecting the environment and the requisite minimum casualties to obtain the objectives and preserve public support.

Accession For	
NTIS GRA&I	<input checked="checked" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

## Table of Contents

CHAPTER I INTRODUCTION . . . . .	1
CHAPTER II INTERNATIONAL LAW, NATIONAL POLICY AND THE RULES OF ENGAGEMENT . . . . .	2
International Law and the Environment . . . . .	3
The Environment and National Security . . . . .	5
Rules of Engagement . . . . .	6
CHAPTER III THE THREATS TO THE ENVIRONMENT . . . . .	8
Nuclear . . . . .	8
Chemical . . . . .	11
Hydrologic . . . . .	14
Petroleum Industry . . . . .	15
CHAPTER IV LIMITATIONS AND OTHER FACTORS . . . . .	20
Weapons Systems . . . . .	20
Special Forces . . . . .	21
The Media . . . . .	22
Intelligence . . . . .	23
CHAPTER V CONCLUSIONS . . . . .	25
APPENDIX A. PRESIDENTIAL EXECUTIVE ORDER 11850 OF 08 APRIL 1975 . . . . .	28
ENDNOTES . . . . .	29
BIBLIOGRAPHY . . . . .	32

# ENVIRONMENTAL WARFARE

## CHAPTER I

### INTRODUCTION

The recent Gulf War demonstrated the overwhelming success of the United States Air-Land Battle doctrine. Unfortunately, the war also brought unprecedented ecological devastation including massive oil spills, bombing attacks on nuclear facilities, burning oil fields, and threats to shut off the flow of the Euphrates River to Iraq.<sup>1</sup> As the world becomes more industrialized, and the indirect effects of weapons become more severe than the direct effects, the potential for environmental catastrophe increases.<sup>2</sup> This fact, along with the lessons of Desert Storm, has focused world criticism on the environmental effects of war, and illuminated the growing general opinion that the Law of Armed Conflict must include protection of the environment as a primary factor in the conduct of war.<sup>3</sup> Consequently, the operational commander must understand how offensive strikes against nuclear, chemical, hydrologic and petroleum facilities may damage the environment; how opponents will use these same forces as a weapon; and the impact that enemy actions will have on operations. To ignore the environmental concerns of the world jeopardizes the popular support of the public--the support that influences international law and national policy, and is critical to a military success.<sup>4</sup>

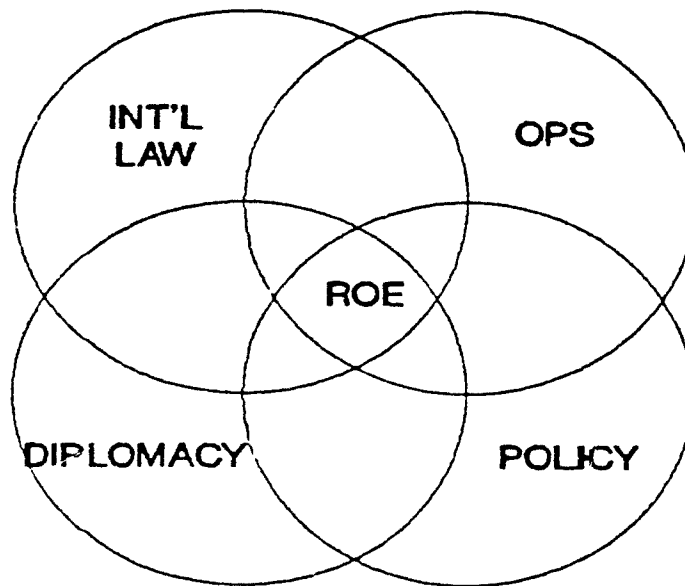
## CHAPTER II

### INTERNATIONAL LAW, NATIONAL POLICY AND THE RULES OF ENGAGEMENT

In future conflicts, as in Desert Storm,<sup>5</sup> the Commander in Chief (CINC) will prepare the war plan which includes the Rules of Engagement (ROE) and the strategic target list based on the objectives determined by the National Command Authorities (NCAs). To develop the ROE, as illustrated in the Venn diagram in Figure 1., the commander must not only understand the military mission, but must also comprehend the underlying international law principles and the national policies, or politics, applicable to the current conflict, and war in general. In a limited war, the

FIGURE 1

#### FACTORS AFFECTING RULES OF ENGAGEMENT



Source: Roach, Ashley, "Rules of Engagement," Naval War College Review, January-February 1983, p. 48.

latter two factors will restrict the acceptable actions of armed forces more so than the restrictions under the law of armed conflict. To illustrate, it is an accepted principle of the law of armed conflict that collateral damage, especially to civilians and their property, must be minimized. Yet, invariably, the commander will include specific ROE that require minimization of collateral damage, or even prohibiting attacks on legitimate military targets that may result in collateral damage as was done in Indochina. There military forces were prohibited from attacking dams in North Vietnam because of the potential for severe collateral damage. The North Vietnamese exploited this restriction by placing military targets such as intercept radars on or in the vicinity of dams.<sup>6</sup> The restrictions on dams were an over-reaction to policy. Failure to understand the legal and political bases of the current environmentalist trends could again result in over-reactions unnecessarily hindering operations.

#### International Law and the Environment

Though they have not been so labelled, international agreements and conventions protecting the environment have been in existence for over one hundred years. The 1863 Lieber Code restricted the means by which the Union Army conducted warfare so as to protect private property. The 1868 Declaration of St. Petersburg stated that the only legitimate objective during war was to weaken the enemies' armed forces.<sup>7</sup> Following the massive destruction caused by various wars between 1868 and 1899, war's havoc was limited through the Regulations of the 1899 and 1907



Hague conventions. These conventions stated that "the right of belligerents to adopt means of injuring the enemy is not unlimited." The conventions also forbade the destruction of enemy property unless the destruction is imperative for military necessity.<sup>8</sup>

World Wars I and II again saw large scale devastation through heavy artillery fire, fire bombings and pillaging. In fact, nine Germans were accused of pillaging, and were subsequently charged with war crimes, for their implementation of the Nazi policy of "ruthless exploitation of Polish forestry."<sup>9</sup> As a result of this and other cases, the 1949 Geneva Convention, Article 53, prohibited destruction of personal property belonging to private individuals, corporations or the State, "except where such destruction is rendered absolutely necessary by military operations."<sup>10</sup>

The next international agreements placed into effect were the 1977 Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD), and the 1977 Additional Protocols to the 1949 Geneva Convention. The ENMOD Convention "commits each party not to engage in military or any other hostile use of environmental modification techniques that cause widespread, long-lasting, or severe destruction, damage or injury to any other state which is a party."<sup>11</sup> The Additional Protocols prohibit the warfare means or methods which "are intended or 'may be expected' to cause widespread, long term, and severe damage to the environment."<sup>12</sup> Though collateral battlefield damage is not specifically covered in these agreements, it should

be noted that the trend is towards prohibiting means or methods that even "may be expected" to cause environmental damage. Interpretations will run from one extreme to another. Environmentalists may expect all means and methods to cause damage, whereas military leaders may expect no widespread, long term or severe damage.

More recent moves, such as the 1982 World Charter for Nature and 1991 meetings in Nairobi, Kenya and Ottawa, call for prohibitions against weapons aimed at the environment, and indirect damage to the environment. The United States has not accepted these moves since they could restrict otherwise lawful military means and methods, but the trend is clear--world opinion will no longer tolerate wantonly deliberate or indiscriminate damage to the environment during times of war.

#### The Environment and National Security

As is the case in international law, public opinion has influenced United States national policies. Environmental laws have been toughened up; recycling is encouraged not only in the private sector, but also in the government; and candidates seeking public office make environmental concerns a major part of their campaign. In his election campaign of 1988, then Vice President Bush stated that he would be the environmental president. Environmental concerns have, in fact, been included in the most recent National Security Strategy. The Gulf War illustrates the evolving links between the environment, resource problems and international conflict.<sup>13</sup> As was stated in the CSIS Interim

report The Gulf War: Military lessons learned, "the deterrence of, and responses to, environmental attacks are new dimensions to national security challenges."<sup>14</sup>

Commanders, while planning and executing an operation, must not ignore the environmental aspects of the operation. Nor is it likely that the NCAs will allow the commander to ignore such sensitive issues and jeopardize public opinion. Desert Storm is a classic example of how environmental destruction can even rouse the support of the people. Coalition leaders were quick to point out the destruction caused by Iraq, and made sure that the media broadcast detailed footage of the destruction. Every briefing included details of the tremendous measures that coalition forces were taking to both prevent damage, and to mitigate the damage caused by Iraq. These actions supplemented the "moral high ground" from which the coalition forces were operating.<sup>15</sup> As will be required in future conflicts, Desert Storm was one in which one side won without using vicious weapons on civilian populations or environmentally sensitive areas. New weapons technology, along with an emphasis on minimizing damage to the environment, allowed the coalition leaders to fight a "clean" war.<sup>16</sup>

#### Rules of Engagement

Rules of Engagement, as defined by CAPT Ashley Roach, JAGC, USN, are the "primary means by which the NCA can provide guidance to deployed forces in wartime for controlling the fighting."<sup>17</sup> As shown in Figure 1, ROE assure that national policy will be followed; provide the upper-bounds of the on-scene commander to

dispose his forces; and provide operational guidance to ensure that actions stay within the limits of law.<sup>18</sup> Focusing on the environment, ROE insure that, within the military objectives, the means and methods of warfare are in compliance with both national concerns for the environment and international legal prohibitions against indiscriminate destruction of the environment. Major K.B. Jordan, USMC, in his article "Petroleum Transport System: No Longer a Legitimate Target," suggests specific ROE which prohibit attacks against offshore wells, crude oil tankers, oil pipelines and storage facilities.<sup>19</sup> With the increased emphasis on environmental protection, future ROE may restrict attacks against a wider range of facilities including chemical production facilities, nuclear plants and reprocessing facilities, oil fields and other potentially precarious facilities. But ROE should not be so restrictive as to unnecessarily prolong the war or cause defeat. They should be written to allow the commander to determine in the field what means and methods are militarily necessary to accomplish the NCAs objectives.

With this premise in mind, the next chapters will examine the types of environmental damage that could be inflicted, how the operational commander may overcome restrictions placed on environmentally sensitive targets and methods, and what the commander may expect from an opposing force.

## CHAPTER III

### THE THREATS TO THE ENVIRONMENT

An operational commander must determine what means and methods are necessary to accomplish the specified military objectives. As discussed in the previous chapter, ROE will restrict the means and methods from which a commander may choose. However, if the ROE are properly composed, they will emphasize the principle of discrimination. This principle does not demand perfection, only restraint within the derived military benefits.<sup>20</sup> The commander must, therefore, weigh the environmental impact against the military benefit obtained in planning operations. The following sections focus on the various forces which may cause severe, long-lasting or widespread damage to the environment, as well as the impact that they may have on operations. Use of nuclear, biological and chemical weapons will not be addressed, but processing and storage facilities as targets will be included under the appropriate headings.

#### Nuclear

Currently, there are over 400 operational nuclear power generating plants located in 25 countries. as well as numerous fuel reprocessing plants, weapons factories, waste storage repositories and research facilities. All of these pose some potential for radiation contamination, but the power and reprocessing plants pose the greatest threat. As late as 1990, people believed that "the worldwide outcry over the environmental

implications of the Chernobyl and Three Mile Island accidents renders the idea of attack against an enemy's nuclear utility plants unthinkable in conventional war."<sup>21</sup> Indeed, until Desert Storm, no belligerent had attempted to target an operational reactor.<sup>22</sup> However, nuclear plants and reprocessing facilities are very tempting targets--plants because of their importance in generating power, and reprocessing facilities because of their importance in weapons production.<sup>23</sup> Yet, targeting such facilities could have serious and widespread impact not only on military personnel, but also on innocent civilians. To understand the potential impact, one should examine the threat both physically and politically, that these facilities pose, as well as past accidents.

Direct attacks on nuclear plants and reprocessing facilities pose the greatest risk of nuclear catastrophe. In a power plant, such attacks would destroy the containment structure, and the integral cooling and control systems. Left uncontrolled, the core could reach critical mass, unleashing devastating nuclear explosions and contaminating a wide area. Direct attacks on reprocessing facilities would probably rupture the large storage systems that are typical in reprocessing facilities, also contaminating a large area.<sup>24</sup> Though direct attacks would destroy the facility, the probable political criticism would far outweigh the military benefit derived. In addition, with current technology, it is not necessary to destroy the reactor or the

reprocessing plant to eliminate their potentials. Indirect methods can be just as effective.

Alternate methods for incapacitating nuclear facilities include striking control facilities or electrical distribution systems using precision guided munitions or special forces. These methods have both advantages and disadvantages. The most critical advantage is the fact that the radiation elements continue to be contained. Disadvantages can best be explained by examining some recent peacetime accidents in the nuclear industry. In one accident, at Brown's Ferry, Alabama, a candle used to test for air leaks ignited cable insulation. Unfortunately, the cables controlled the core cooling systems, rendering them useless. Had the operators not rigged a bypass system, the core would have reached critical mass.<sup>25</sup>

Another example is the incident at Three Mile Island. At that plant, a normal routine combined with an operator error, resulting in a major loss of coolant accident. The main feed water was shut down at the same time as the auxiliary valves were closed. Fortunately, the system was flooded before the containment vessel ruptured. The accident at Chernobyl was also operator error. In that case, the operators were testing to determine if the coasting-down turbine generator could maintain power to the emergency core cooling system in the event of an off-site power failure. It obviously would not, and the result was the worst nuclear accident to date.<sup>26</sup> These accidents happened in peacetime when all resources were available and could be directed towards the crisis.

During a conflict, especially if the plant itself were targeted, many resources may be engaged in other crises, increasing the potential for accidents.

The political implications of targeting the nuclear industry should be considered the most serious. Such attacks call into question the effectiveness of the international system for limiting nuclear proliferation. Attacks on the nuclear infrastructure also open the door to more catastrophic attacks, and leave hostile countries and terrorists with the impression that the nuclear industry is not only a benign target, but a legitimate one.<sup>27</sup> Many of these countries either do not have the capabilities or the willingness to conduct limited surgical strikes. Consequently, attacks on friendly nuclear facilities could endanger not only friendly forces, but also more innocent civilians. Consequently, nuclear facilities could be a nuclear weapon in the hands of an opponent, requiring defensive forces that could be more effectively utilized elsewhere.

#### Chemical

By virtue of its diverse and widespread presence, the chemical industry poses a greater overall threat than does the nuclear industry. Chemicals are manufactured throughout the world, and include common insecticides, manufacturing and cleaning compounds, and chemical weapons. In fact, since chemicals are easily obtained on the open market, and involve less technology to produce, chemical weapons are considered the "poor man's nuclear weapon." Hence, they are potentially legitimate targets. In addition,



because of their ties to industry, chemical plants are generally located in industrial complexes, many of which are targeted as supporting the war efforts of a belligerent. Consequently, the plants are subject to collateral damage as well.<sup>28</sup>

The environmental threat from chemicals assumes several forms. First, since a side effect of bombing tends to be fire, any fires at chemical plants are probably going to emit toxic fumes with the smoke. Next, many chemicals are subject to flashing, especially those that are stored under pressure. When suddenly released into the atmosphere, such chemicals as chlorine, ammonia and propane can explosively vaporize, forming a vapor cloud that will then be subject to the wind, weather and terrain. Since such chemical clouds are generally uncontrollable, and frequently heavier than air, they will spread out over the landscape, effecting all life indiscriminately.<sup>29</sup> The potential for chemical effects from toxic smoke and/or vapor clouds on neutral third parties is great.<sup>30</sup>

Several past accidents illustrate the carnage that could result from indiscriminate targeting of chemical facilities. In 1943 in Bari, Italy, mustard gas escaped, killing over 100 people, both military and civilian. In 1968, in Skull Valley, Utah, VX gas escaped killing over 4,000 sheep.<sup>31</sup> By far the worst case occurred in Bhopal India, at a plant manufacturing "SEVIN" insecticide. Water mixed with methyl-isocyanate, causing an exothermic reaction. The resulting gas cloud spread out over the population, killing 2,300 and injuring some 30,000 to 40,000 people. As with the nuclear accidents previously discussed, these

chemical accidents occurred when emergency procedures could be dedicated to the crisis at hand. The "fog" of war will make such accidents more devastating.

The commander can minimize the potential of chemical releases by using precision guided munitions or special forces to strike key components of a plant. Such strikes may indeed put a plant out-of-commission, but at what cost? Weapons, both smart bombs and hand-placed charges, can be very powerful and cause tremendous collateral damage.<sup>32</sup> As noted above, even collateral damage can cause a catastrophic chemical release. No one has succeeded in controlling the wind and weather, so even small releases, if they are in a highly populated area, subject civilians to risk. Finally, if a chemical release does occur, killing many civilians, or even military, can this release be considered "first use" of chemical weapons, opening the door for reprisal? These are serious questions that must be addressed before conducting strikes on chemical facilities.

Also falling under the heading of chemical warfare is the use of herbicides. The United States, by Executive Order 11850, declared that it would not use herbicides except for vegetation control around bases. This declaration resulted from the public condemnation voiced following the Vietnam war. However, use of herbicides is not forbidden by law, and their use by Third World nations could occur, especially in insurgencies, counter-insurgencies,<sup>33</sup> or possibly drug interdiction and eradication programs. Herbicides have devastating effects on the landscape

and the food chain, as demonstrated in Indochina, where over 17,000 KM<sup>2</sup> of forest areas were damaged, including 1,510 KM<sup>2</sup> of mangrove forest, still muddy wastelands today.<sup>34</sup> Future uses of herbicides promise to be more damaging due to the higher concentrations available, the ability to be species specific, and the possibility of soil sterilization. Because of the danger to the environment and people exposed, herbicides should be prohibited. However, the United States must plan for hostile forces using herbicides, especially in low intensity conflicts.

#### Hydrologic

Hydrologic environmental warfare deals mainly with the use and abuse of dams and other water retaining structures. In addition, controlling water flow for hostile uses will be briefly discussed.

Dams, levees and dikes are static structure that in themselves do not pose a serious threat. However, they are easily destroyed by small, strategically placed explosives or bombs. The massive quantities of water that dams retain, when unleashed, can cause severe damage to both the environment and to innocent civilians. "Large dams, like nuclear power plants, are potential weapons in the hands of enemies."<sup>35</sup>

Dams are targeted primarily for their use as power generating plants. However, several incidents in World War II, Korea and Vietnam demonstrate their potential as targets for other reasons. In World War II, the allies destroyed three dams in the Ruhr Valley in order to wipe out the industrial capacity of the area. The operation was a success, destroying 125 factories and 12 power

stations. However, 1,300 civilians were killed, and 120,000 were left homeless. Such indiscriminate destruction would have serious political implications today.

In Korea, dams and dikes in North Korea were targeted in an effort to wipe out crops and deny food to the enemy. The success of this program is questionable. In the Indochina war, dams in North Vietnam were specifically excluded from target lists because of the danger to civilians. The North Vietnamese sensed this reluctance to target dams, and moved military equipment and systems into the vicinity and even onto dams themselves as a defensive measure.<sup>36</sup>

Another hydrologic threat is flow control of rivers. Anywhere a river or river system flows through more than one country, an upstream country with control over a dam system could divert water or deny flow to a downstream country.<sup>37</sup> Though this threat appears to be small, the President of Turkey, in the mid-eighties, threatened to use the Ataturk dam to restrict the flow of the Euphrates river into Syria to force Syria to withdraw support of Kurdish Separatists.<sup>38</sup> The same threat was levied against Iraq during the recent Desert Shield Operation.<sup>39</sup> Since fresh water supplies are now considered national security interests, this type of environmental manipulation may not only cause public criticism, but may ultimately lead to major confrontations. This practice should be prohibited as a means of war.

#### Petroleum Industry

Two areas will be examined under the heading of petroleum industry: (1) oil spills, both on land and in water; and (2) oil fires, principally on land. Though these two types of environmental warfare are not new, their use was reduced to an art during the recent Persian Gulf Conflict, and currently have the attention of the world. Consequently, some valuable lessons should be extracted for future planning.

Oil spills have occurred throughout the world, both during peacetime and times of war, ever since the world became dependent on oil as an energy source. Oil wells are located both on land and at sea. Oil pipelines traverse entire countries, through urban and rural areas. Five thousand tankers, nearly one quarter of all shipping, are at sea at any one time.<sup>40</sup> In the past, since oil is vital to conduct war, any segment of the oil production and distribution industry was a legitimate and prime target. However, with today's environmental concerns, indiscriminate releases of oil are not acceptable, and striking such targets exclusively to interdict the fuel process is no longer justified. With advanced technology, as well as the highly trained Special Forces, the fuel industry can be crippled by destroying gas-oil separation systems at refineries, or the distribution points in the "downstream" side of the process. Large volume targets such as storage facilities or tankers should be avoided,<sup>41</sup> since the military benefit cannot outweigh the political condemnation that would result from a nation causing a massive oil spill.

Even though causing an oil spill is virtually diplomatic suicide, Desert Storm proved that opponents will intentionally or accidentally create an oil spill. One need only review the facts of the Iraqi-caused oil spill in the Persian Gulf to determine how a spill will effect operations. One may be assured that future opponents have extracted lessons for future consideration.

Coalition leaders, given the nature of the area, planned for an oil spill, but not for the magnitude that actually occurred.<sup>42</sup> After discovering the spill, the Department of Defense set up a 24-hour Spill Task Force to monitor the movement. Leaders quickly realized that the spill, if it moved down the Saudi coast, would threaten the desalinization plants located to the south, possibly creating shortages of water for not only the civilian population, but military forces as well. Air strikes were successfully conducted against the on-shore oil manifolds to stop the flow of oil into the Gulf. But the impact on operations did not end at this point. Though the oil probably would not have effected naval operations, there was fear that the oil might be ignited, or that the oil would be sucked up into cooling systems. Therefore, naval vessels navigated around the oil slick.<sup>43</sup> Officials stated repeatedly that the oil would have no effect on amphibious operations, but a Marine Officer was quoted as stating that the Amtracks might have encountered problems because of the small freeboard that they have. Regardless, the operation would have been messier.<sup>44</sup>

Finally, various organizations, including the Coast Guard, Environmental Protection Agency and the National Oceanic and Atmospheric Administration, requested assistance in monitoring the oil spill, causing attention, if not multiple assets, to be focused on the spill vice the war at hand.<sup>45</sup> Numerous organizations volunteered to assist in the clean-up operations, but it was wisely deemed too dangerous to do so in a war zone.<sup>46</sup> However, significant numbers of naval and air assets may have to be diverted to protect the clean-up efforts in future conflicts.<sup>47</sup>

The Iraqi military not only dumped oil into the Gulf, they also set fire to some seven hundred oil wells located throughout the Kuwaiti oil fields. Recent history reveals that destroying oil wells is not a new idea. In the early seventies, during the gas crisis, both Kuwait and Saudi Arabia threatened to blow up their oil fields if the United States attempted to intervene. In fact, both countries had positioned explosives on the wells in what Saudi Arabia affectionately called "Operation Detonation."<sup>48</sup> Kuwait and Saudi Arabia intended to deny the oil supply to the United States. One may presume that Iraq had the same objective with a scorched earth policy, but what other effects did the fires have on coalition operations? First, smoke is frequently used as an obscurant, to hide avenues of approach, to deny reconnaissance observations,<sup>49</sup> and to cause general confusion on the part of the enemy. Though he may not have intended these results, Hussein did accomplish them to some degree.

Coalition operations were adversely impacted by the smoke generated by the fires, and by the oil intentionally released oil. "Air support was severely hampered,"<sup>50</sup> satellite imagery was degraded (which also effected battle damage assessment), and reconnaissance flights were less effective. The oil trenches that were constructed and set afire had to be overcome. Oil spilling from unlit wells formed oil "lakes," some of which were several kilometers across and more than a meter in depth. The crusty surfaces that form on these lakes create pockets of gas. The lethality of these pockets was discovered when five people were killed when they crossed one of the pools and ignited the underlying gases.<sup>51</sup> These pools of oil can also hide unexploded ordnance or mines.

Finally, the smoke, and subsequent fallout, effected the overall environment as well as the personnel exposed. At the height of the fires, clouds were so dense that cars used headlights at midday; hospitals were filled with the very young, elderly and others who suffered respiratory problems; tons of sulfur dioxide, the main ingredient of acid rain, were released into the air; and high levels of cadmium, lead and other toxins were detected in the smoke.<sup>52</sup> Research plane crews flying through the smoke wore gas masks as a precaution against the toxins. In fact, pollutants inside the aircraft caused throat irritation. So how does this effect the coalition forces who were conducting offensive operations amongst the burning wells? The U.S. Army Environmental Hygiene Agency is monitoring the health of members of the 11th



Armored Cavalry Regiment who were in theater for a period of about three months.<sup>53</sup> Results of the study are due out this spring, and should be analyzed to determine how operations should be modified in future encounters of this type.

## CHAPTER IV

### LIMITATIONS AND OTHER FACTORS

Political restrictions and the potential for ecological damage are not the only restrictive controls on theater operations. Several other factors, including availability of weapons systems, availability of special forces, the ever increasing role of the media, and the importance of intelligence, will influence warfare means and methods. The commander must determine which of these other factors will play a role in restricting or otherwise directing an operation, and plan accordingly.

#### Weapons Systems

Coalition leaders emphasized the ability of the military to conduct surgical strikes using smart weapons to literally "hit the nail on the head." The general public, seeing all of the video footage of precision hits, gained the impression that coalition forces were using only precision weapons and inflicting serious damage to the targets while inflicting virtually no collateral damage to surrounding facilities. However, this was not the case. There was a total of 88,500 tons of munitions used during Desert Storm. Of that total, only 7.4%, or 6,500 tons, were precision guided ordnance. The rest were destructive conventional munitions.<sup>54</sup> The reason for this unequal distribution of munitions is simple--cost. Precision guided munitions, because of the advanced technology that they utilize, are very expensive. No country can afford to equip all of their forces exclusively with

such costly weapons. Therefore, the quantity of smart weapons available in theater will be a limiting factor for the commander, especially since damage inflicted while minimizing environmental damage may be quickly repaired, requiring subsequent restrikes. Smart weapons are usually reserved for high value targets that must be taken out quickly, such as command and control assets. These targets are usually more heavily defended, and using smart weapons will reduce the exposure of pilots to hostile fire by eliminating the target the first time. The commander must determine what is more politically and operationally critical--subjecting friendly forces to hostile fire or reducing potential for environmental damage.

#### Special Forces

The same considerations that apply to smart weapons also apply to Special Forces. Special Forces, such as SEALs or Rangers, are trained to penetrate behind enemy lines and conduct offensive operations such as sabotage. This type of training would be ideal for some of the targets discussed in the previous chapter, especially nuclear power plant controls, power distribution systems, chemical processing plants and oil refineries. Special Forces could place charges precisely in locations to create the maximum damage with the least amount of collateral damage. The threat to the environment would be minimized, and the military operations would not be restricted. Special Forces could also mitigate some damage caused by an opponent. For example, in Desert Storm, Special Forces could have penetrated into the oil fields and

removed some of the explosives on the wells.<sup>55</sup> However, as mentioned above, two factors must be considered: (1) the availability of the Special Forces; and (2) the priority of minimizing potential damage to the environment. Addressing the former factor, Special Forces are usually reserved for critical targets, such as command and control or air defenses. Pulling some assets from this mission to strike environmentally sensitive targets may leave enemy air defenses operational, further jeopardizing friendly forces. With respect to the latter factor, the commander must determine if placing personnel directly in danger to protect the environment is politically necessary.

#### The Media

During the war, the average citizen grabbed the remote, settled down in an easy chair, switched on Cable News Network (CNN), and played "armchair commander." This was the first conflict where war footage was beamed around the world essentially in "real time." Any commander involved in a regional conflict in the future must extract at least this lesson from Desert Storm--the media can help leaders secure the confidence and support of the public. Leaders held daily conferences during which they outlined in detail, limited by security considerations, what was happening in the theater of operations. The success of Desert Storm was vividly portrayed, with some of the most powerful images being those of the smart bomb videos.<sup>56</sup> As mentioned above, the general public got the impression that precision guided munitions were the

weapon of choice, and that collateral damage was minimal. General Schwarzkopf himself briefed the media, live, stating,

"We're using the appropriate weapons against the appropriate targets. We're being very, very careful in our directions of attacks to avoid damage of any kind to civilian installations."<sup>57</sup>

Once the environmental warfare tactics of Iraq were discovered, the media was used as a channel to expose the devastation to the world. The public learned first hand about the oil spill in the Gulf, and saw immediately the concern that the leaders had for stopping the flow, as well as preventing any additional spills. The precision guided munitions videos showing the strike on the manifolds were presented to support the attention that the environmental damage had gained. This lesson must not be forgotten--the media, effectively utilized, will not only gain more support for coalition actions, but can also fuel international criticism against an opponent for conducting environmental terrorism like that levied against the Gulf Region.

#### Intelligence

Intelligence--image, electronic and human--is essential to determine which target poses an environmental threat, and which weapon to use to eliminate the target. One must know both the weak points that make a target vulnerable, and the features that can be environmentally dangerous. Storage tanks must be identified. Capabilities for handling multiple emergencies must be determined. After the strike is complete, battle damage assessment must determine if the mission was a success, and how much collateral damage was caused. This information is difficult to get at best,

and will usually fall well below such C<sup>3</sup>I requirements as air defenses on the commander's priority list for the scarce available assets. But failure to obtain this information may result in an environmental disaster that drives public opinion to sympathize with the opposing side.

The above are a few of the related limitations and factors that could influence the means and methods that a commander may use to accomplish the objectives. Though they may not in all cases influence the how the environment is used or abused, these factors should at least be reviewed as an attempt to minimize ecological destruction.

## CHAPTER V

### CONCLUSIONS

Given that in the future, conflicts will most likely be regional, one may expect that the aims and objectives will be limited in nature. Almost by definition, the more limited the war, the more political the war. This is definitely true when the United States is involved in a coalition. Consequently, CINCs will have to be more attuned to the National Policies so as to maintain support for on-going operations. As has been shown above, the environment is very much a part of the National Strategy, and is becoming more of an international concern with each passing day. CINCs must consider how their operations will effect the environment relative to international law and national policy.

Rules of Engagement provide guidance to the CINCs on how to conduct operations within the limits of law and policy. ROE restricting environmental damage will place additional constraints on operations. However, one must also understand that national policy, and diplomatic considerations, will act as restraining factors. International law is permissive enough to allow for some environmental damage since it stresses discrimination and military necessity. Discrimination does not require perfection, but the NCAs may. CINCs will have to determine how to define discrimination and military necessity relative to operational objectives.

Many facilities exist in the world today that can cause severe environmental damage. Such facilities as nuclear plants, chemical processing plants, dams, and petroleum facilities have tremendous potential for devastating an area, yet they remain legitimate targets, and justifiably so since they can support war efforts. CINCs and Task Force commanders must determine if any of these facilities are truly critical to obtaining objectives. If the answer is affirmative, the commander must choose the strike method carefully. Some weapons, such as conventional bombs, are less precise and more destructive, than say, precision guided munitions (PGM). On the other hand, using all of the PGM on environmentally sensitive targets may prevent forces from taking out critical enemy C<sup>3</sup>I assets, or require multiple strikes. The same concerns are true with the use of Special Forces. Balancing the threat to personnel and environmental devastation will not necessarily be easy, especially since both factors can so effect world opinion.

Other factors will also make such decisions more difficult. Intelligence is critical if one hopes to strike only critical components of a nuclear, chemical or petroleum facility. Yet, these assets, like the weapons and Special Forces, are usually in short supply. In addition, battle damage assessment to determine if a surgical strike was successful can be difficult if there is a great deal of smoke. This again points to placing personnel in the role of reconnaissance, again jeopardizing lives for the environment. The commander must consider, is the trade-off worth it?



Finally, the very considerations that prevent the United States from conducting operations that damage the environment may be justification for an opponent to carry out the operations. For example, commanders may deem it diplomatically infeasible to conduct strikes because it would unleash chemicals, fire or petroleum spills that would devastate the landscape. An opponent may wish to accomplish just that, to deny the use of the land in a scorched earth policy. In the hands of such an opponent, many facilities are just more and bigger weapons. United States aims may be limited, whereas opponent aims may be unlimited.

Desert Storm provided many lessons to the world on environmental warfare. Future opponents observed naval vessels navigating around oil spills, and amphibious operations planned for the area of the spill canceled. They saw much coalition attention and efforts devoted to mitigating the environmental damage unleashed on the Gulf. Nuclear facilities were attacked, removing some of the mystique as to the results of such an attack. Most importantly, the world saw a country unhesitatingly use ecological warfare, and to date virtually go unpunished.

Coalition leaders learned that opponents will use such tactics, and that they will have to exert tremendous effort to mitigate damage. They also learned that the media can be a friend, making the world aware of the destruction, and rousing support for the coalition fighting a "clean war." Most importantly, leaders learned that protection of the environment, even in times of war, must be a priority.

## APPENDIX A

### PRESIDENTIAL EXECUTIVE ORDER 11850 OF 08 APRIL 1975

"The United States renounces, as a matter of national policy, first use of herbicides in war except use, under regulations applicable to their domestic use, for control of vegetation within US bases and installations or around their immediate defensive perimeters, and first use of riot control agents in war except in defensive military modes to save lives such as:

- (a) Use of riot control agents in riot control situations in areas under direct and distinct US military control, to include controlling rioting prisoners of war.
- (b) Use of riot control agents in situations in which civilians are used to mask or screen attacks and civilian casualties can be reduced or avoided.
- (c) Use of riot control agents in rescue missions in remotely isolated areas, of downed aircrews and passengers, and escaping prisoners.
- (d) Use of riot control agents in rear echelon areas outside the zone of immediate combat to protect convoys from civil disturbances, terrorists, and paramilitary organizations.

I have determined that the provisions and procedures prescribed by this Order are necessary to ensure proper implementation and observance of such national policy.

Now, therefore, by virtue of the authority vested in me as President of the United States of America by the Constitution and laws of the United States and as Commander-in-Chief of the Armed Forces of the United States, it is hereby ordered as follows:

SECTION 1. The Secretary of Defense shall take all necessary measures to ensure that the use by the armed forces of the United States of any riot control agents and chemical herbicides in war is prohibited unless such use has Presidential approval, in advance.

SECTION 2. The Secretary of Defense shall prescribe the rules and regulations he deems necessary to ensure that the national policy herein announced shall be observed by the Armed Forces of the United States."

(Signed)  
GERALD R. FORD  
President of the United States

Source: Headquarters Departments of the Army and the Air Force, Military Operations in Low Intensity Conflict, Field Manual 100-20, Air Force Pamphlet 3-20, 05 December 1990, pp. B-1-B-2.

## ENDNOTES

1. Peter H. Gleick, "Environment and Security: The Clear Connections," The Bulletin of the Atomic Scientists, April 1991, p. 17.
2. Arthur H. Westing, ed., Environmental Hazards of War, London: Sage Publications, 1990, p. 1-2.
3. Arthur H. Westing, ed., Environmental Warfare: A Technical, Legal and Policy Appraisal, Philadelphia: Taylor and Francis, 1984, p. 42.
4. Kevin B. Jordan, "Petroleum Transport System: No Longer a Legitimate Target," Naval War College Review, Spring 1990, p. 47.
5. W. H. Parks, "Rules of Engagement: No More Vietnams," Proceedings, March 1991, p. 28.
6. Ibid., p. 27.
7. James P. Terry, "The Environment and the Laws of War: The Impact of Desert Storm," Naval War College Review, Winter 1991, p. 62.
8. Ibid.
9. Westing, ed., Environmental Warfare, p. 37.
10. Terry, p. 63.
11. Ibid., p. 64.
12. Ibid.
13. "The War Metaphor," The Bulletin of the Atomic Scientists, April 1991, p. 2.
14. James Blackwell, et al, The Gulf War: Military Lessons Learned, CSIS Study Group, July 1991, p. 13-2.
15. George A. Lopez, "The Gulf War: Not so Clean," The Bulletin of the Atomic Scientists, September 1991, p. 31
16. Nicholas G. Fotion, "The Gulf War: Cleanly Fought," The Bulletin of the Atomic Scientists, September 1991, p. 25.
17. J. Ashley Roach, "Rules of Engagement," Naval War College Review, January-February 1983, p. 47

18. Ibid., pp. 47-49.
19. Jordan, p. 51.
20. Fotion, p. 28.
21. Jordan, p. 47.
22. Larry B. Stammer, "Attacks on Reactors Set A Precedent," The Los Angeles Times, 26 January 1991, A6:1-2, A31:1-3.
23. Gleick, p. 19.
24. Westing, Environmental Hazards, p. 11-13.
25. Ibid., p. 18-21.
26. Ibid., pp. 18-21.
27. Stammer.
28. Westing, Environmental Hazards, p. 36.
29. Ibid., pp. 34-35.
30. Stockholm International Peace Research Institute, Weapons of Mass Destruction and the Environment, London: Taylor and Francis, 1977, p. 45.
31. Ibid.
32. Westing, Environmental Hazards, pp. 30-36.
33. Stockholm International Peace Research Institute, Weapons, p. 44.
34. J.P. Robinson, The Effects of Weapons on Ecosystems, New York: Pergamon Press, 1979, pp. 44-51.
35. Daniel Deudney, "Environment and Security: Muddled Thinking," The Bulletin of the Atomic Scientists, April 1991, p. 26.
36. Westing, Environmental Hazards, pp. 38-47.
37. Westing, Environmental Warfare, p. 6.
38. Gleick, p. 20.
39. Ibid., p. 18.
40. Westing, Environmental Warfare, p. 9.

41. Jordan, p. 50.
42. John M. Broder, "Spill: Iraq Unleashing Oil into Gulf Waters," The Los Angeles Times, 24 January 1991 pp. A1:6, A6:3-6, A19:1-3.
43. Blackwell, p. 13-1.
44. Broder, "Spill: Iraq Unleashing Oil."
45. Ibid.
46. Kim Murphy, "US Bombing Appears to Shut Off Flow of Oil," The Los Angeles Times, 29 January 1991. A1:4, A7:1-6.
47. Broder, "Spill: Iraq Unleashing Oil."
48. Stockholm International Peace Research Institute, Oil and Security, New York: Humanities Press, 1974, p. 38.
49. Blackwell, p. 13-1.
50. Blackwell, p. 13-2.
51. John Horgan, "Science and the Citizen: Burning Questions," Scientific American, July 1991, p. 24.
52. Ibid., pp. 17-24.
53. Sylvia A. Earle, "Persian Gulf Pollution: Assessing the Damage One Year Later," National Geographic, February 1992, pp. 128-129.
54. Paul F. Walker and Eric Stambler, "And the Dirty Little Weapons," The Bulletin of the Atomic Scientists, May 1991, p. 22.
55. Ed Badolato, "Pollution as Ammunition," Proceedings, October 1990, p. 69.
56. Daniel Hallin, "TV's Clean Little War," The Bulletin of the Atomic Scientists, May 1991, p. 17.
57. Lopez, p. 31.

## BIBLIOGRAPHY

- Badolato, Ed. "Pollution as Ammunition." Proceedings. October 1990, pp. 68-70.
- Blackwell, James et al. The Gulf War: Military Lessons Learned. CSIS Study Group, July 1991. pp. 13-1-13-2.
- Broadus, James M. "The Sea Environment: Good News, Bad News." Proceedings. October 1991, pp. 50-55.
- Broder, John M. "Spill: Iraqi Unleashing Oil into Gulf Waters." The Los Angeles Times. 24 January 1991 pp. A1:6, A6:3-6, A19:1-3.
- Deudney, Daniel. "Environment and Security: Muddled Thinking." The Bulletin of the Atomic Scientists. April 1991, pp. 22-28.
- Earle, Sylvia A. "Persian Gulf Pollution: Assessing the Damage One Year Later." National Geographic. February 1992, pp. 122-134.
- Flaherty, Francis J. "Boom, Buzz, Bomb: How High the Sky, How Low the Jets." The Progressive. January 1991, pp. 25-27.
- Fotion, Nicholas G. "The Gulf War: Cleanly Fought." The Bulletin of the Atomic Scientists. September 1991, pp. 24-29.
- Gasperini, William. "Kuwaitis Assess Oil Damage." The Christian Science Monitor. 12 November 1991.
- Gleick, Peter H. "Environment and Security: The Clear Connections." The Bulletin of the Atomic Scientists. April 1991, pp. 16-21.
- Hallin, Daniel. "TV's Clean Little War." The Bulletin of the Atomic Scientists. May 1991, pp. 17-19.
- Hoffman, Michelle. "Taking Stock of Saddam's Fiery Legacy in Kuwait." Science. 30 August 1991, p. 971.
- Horgan, John. "Science and the Citizen: Burning Questions." Scientific American. July 1991, pp. 17-24.
- \_\_\_\_\_. "Science and the Citizen: Up in Flames." Scientific American. May 1991, pp. 17-24.
- "Iraq, Continued." The Bulletin of the Atomic Scientists. May 1991. p. 2.

- "Iraq's Apocalypse." The Bulletin of the Atomic Scientists. April 1991. p. 2.
- Jordan, Kevin B. "Petroleum Transport System: No Longer a Legitimate Target." Naval War College Review. Spring 1990, pp. 47-53.
- Lopez, George A. "The Gulf War: Not so Clean." The Bulletin of the Atomic Scientists. September 1991, pp. 30-35.
- Miller, John A. "Countering the Iraqi Eclipse." The Military Engineer. January-February 1992, pp. 4-8.
- Murphy, Kim. "US Bombing Appears to Shut Off Flow of Oil." The Los Angeles Times. 29 January 1991. A1:4, A7:1-6.
- Parks, W.H. "Rules of Engagement: No More Vietnams." Proceedings. March 1991, pp. 27-28.
- Parrish, Michael. "Oil Spill Threatens Region's Water Supply with Disaster." The Los Angeles Times. 24 January 1991, pp. A6:1-3, A15:1-3.
- Roach, J. Ashley. "Rules of Engagement." Naval War College Review. January-February 1983, pp. 46-55.
- Robinson, J.P. The Effects of Weapons on Ecosystems. New York: Pergamon Press, 1979.
- "The Spoils of War: Damaged Economies...Devastated Ecologies." UN Chronicle. June 1991, pp. 16-18.
- Stammer, Larry B. "Attacks on Reactors Set A Precedent." The Los Angeles Times. 26 January 1991, A6:1-2, A31:1-3.
- Stockholm International Peace Research Institute. Oil and Security. New York: Humanities Press, 1974.
- \_\_\_\_\_. Weapons of Mass Destruction and the Environment. London: Taylor and Francis, 1977.
- Terry, James P. "The Environment and the Laws of War: The Impact of Desert Storm." Naval War College Review. Winter 1991, pp. 61-67.
- Walker, Paul F., and Stambler, Eric. "And the Dirty Little Weapons." The Bulletin of the Atomic Scientists. May 1991, pp. 21-24.
- "The War Metaphor." The Bulletin of the Atomic Scientists. April 1991, p. 2.

- "Iraq's Apocalypse." The Bulletin of the Atomic Scientists. April 1991. p. 2.
- Jordan, Kevin B. "Petroleum Transport System: No Longer a Legitimate Target." Naval War College Review. Spring 1990, pp. 47-53.
- Lopez, George A. "The Gulf War: Not so Clean." The Bulletin of the Atomic Scientists. September 1991, pp. 30-35.
- Miller, John A. "Countering the Iraqi Eclipse." The Military Engineer. January-February 1992, pp. 4-8.
- Murphy, Kim. "US Bombing Appears to Shut Off Flow of Oil." The Los Angeles Times. 29 January 1991. A1:4, A7:1-6.
- Parks, W.H. "Rules of Engagement: No More Vietnams." Proceedings. March 1991, pp. 27-28.
- Parrish, Michael. "Oil Spill Threatens Region's Water Supply with Disaster." The Los Angeles Times. 24 January 1991, pp. A6:1-3, A15:1-3.
- Roach, J. Ashley. "Rules of Engagement." Naval War College Review. January-February 1983, pp. 46-55.
- Robinson, J.P. The Effects of Weapons on Ecosystems. New York: Pergamon Press, 1979.
- "The Spoils of War: Damaged Economies...Devastated Ecologies." UN Chronicle. June 1991, pp. 16-18.
- Stammer, Larry B. "Attacks on Reactors Set A Precedent." The Los Angeles Times. 26 January 1991, A6:1-2, A31:1-3.
- Stockholm International Peace Research Institute. Oil and Security. New York: Humanities Press, 1974.
- \_\_\_\_\_. Weapons of Mass Destruction and the Environment. London: Taylor and Francis, 1977.
- Terry, James P. "The Environment and the Laws of War: The Impact of Desert Storm." Naval War College Review. Winter 1991, pp. 61-67.
- Walker, Paul F., and Stambler, Eric. "And the Dirty Little Weapons." The Bulletin of the Atomic Scientists. May 1991, pp. 21-24.
- "The War Metaphor." The Bulletin of the Atomic Scientists. April 1991, p. 2.



Warner, Sir Frederick. "The Environmental Consequences of the Gulf War." Environment. June 1991, pp. 7-9, 25-26.

Westing, Arthur H., ed. Environmental Hazards of War. London: Sage Publications, 1990.

\_\_\_\_\_. Environmental Warfare: A Technical, Legal and Policy Appraisal. Philadelphia: Taylor and Francis, 1984.

Zimmer, Carl. "Ecowar." Discover. January 1992, pp. 37-39.